The Johns Hopkins University
Chemical Propulsion Information Agency
CPIA
Serving the Propulsion Community for Over Fifty Years
A DISA/DTIC-Sponsored DoD Information Analysis Center
Bulletin
Vol. 26, No. 3, May 2000

The JHU Applied Physics Laboratory Continues a Long History of Propulsion Research

The Johns Hopkins University Applied Physics Laboratory (JHU/APL) has been involved with rocket and missile propulsion as a technology developer, as an evaluator of propulsion technology, and as a user of propulsion units for over fifty years. JHU/APL has been at the forefront of research and development in ramjet, scramjet, and mixed-cycle air-breathing propulsion systems since 1944, with the development and first successful flight test of a surface-launched, supersonic ramjet for the U.S. Navy. This leading edge high-speed air-breathing propulsion research continues today at APL with the development and evaluation of propulsion technology for the U.S. Navy Hypersonic Weapon Technology (HWT), the U.S. Air Force Hypersonic Technologies (HyTech), DARPA's Affordable Rapid Response Missile Demonstrator (ARRMD), and NASA's Access-To-Space [using Rocket-Based-Combined-Cycle (RBCC) propulsion] programs.

In parallel, JHU/APL has also maintained a longstanding expertise in systems engineering, in its role as a technical development agent for a variety of aerospace systems and military and civilian space systems, and has consequently sustained its capability to evaluate and to apply rocket propulsion technology to these systems. JHU/APL's sponsors include the U.S. Navy (NAVAIR, NAVSEA, SSP, and others), the U.S. Air Force, DARPA, and NASA. JHU/APL conducts various propulsion system analysis and evaluation tasks for U.S. Navy ship defense and tactical air-launched missile development programs.

JHU/APL's airbreathing propulsion efforts are led by Paul Waltrup, Dave Van Wie and Mike White in the Research and Technology Development Center (RTDC). JHU/APL is the lead organization for propulsion technology development, integration and performance for the ONR Hypersonic Weapons Technology program. As part of this effort the APL is preparing for tests of advanced Dual-Combustor Ramjet (DCR) hardware under the guidance of Steve D'Alessio. For the ARRMD program, APL serves as the Lead Technical Advisor for DARPA, working closely with the Boeing-led industry team to develop a hypersonic cruise missile flight demonstrator. For the USAF HyTech program, JHU/APL is a technical advisor to the Air Force Research Lab program office. Led by Michael Thompson, APL is working closely with Pratt & Whitney on the testing of their HyTech engine concept. Finally, for NASA, JHU/APL is evaluating conceptual design and performance estimates for access-to-space vehicles powered by RBCC engines, evaluating RBCC experimental data and assessing optimum component performance. JHU/APL is also working with Russian researchers at several Institutes and Universities to examine and develop advanced technologies applicable to scramjet engines and hypersonic fluid dynamics.

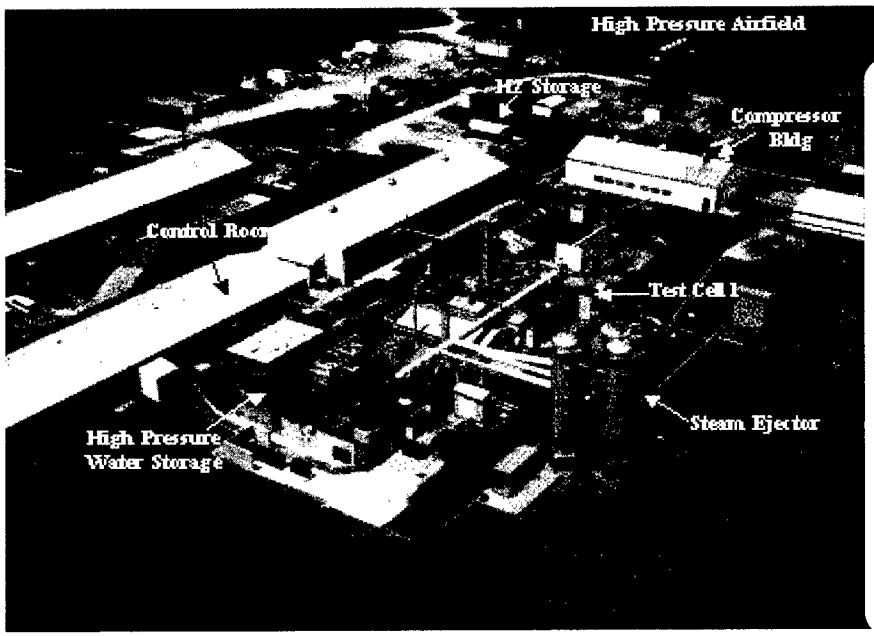


Figure 1. W. H. Avery Advanced Technology Development Laboratory

JHU/APL recently initiated several internal research and development (IRAD) projects to investigate fundamental aspects

continued on page 4

Contents:

CPIA's Technical/ Bibliographic Inquiry Service

CPIA offers a variety of services to its subscribers, including responses to technical/bibliographic inquiries. Answers are usually provided within three working days, and take the form of telephoned, telefaxed, electronic or written technical summaries. Customers are provided with copies of JANNAF papers, excerpts from technical reports, bibliographies of pertinent literature, names of recognized experts, propellant/ingredient data sheets, computer program tapes and instructions, and/or theoretical performance calculations. The CPIA staff responds to nearly 800 inquiries per year from over 180 customer organizations. CPIA invites inquiries via telephone, fax, e-mail, or letter. For further information, please contact Tom Moore at (410) 992-7306, or e-mail: tmoore @jhu.edu. Representative recent inquiries include:

Technical Inquiries

- RP-1 data and specification (TI1999112204).
- N-100 polyisocyananate properties and characterization (TI2000010306).
- Mechanical properties of CTPB propellants at low temperatures and various strain rates (TI2000022801).
- Rocket motors using tungsten nozzle throat inserts (TI12000022201).
- Use of silicone flexseals in rocket motors (TI2000022501).
- Aging and surveillance of Mk 12 Mod 1 Terrier propellants (TI2000030201).

Bibliographic Inquiries

- 9DT-NIDA and ORP-2 energetic binders (BI2000012002).
- Lead-free propellant development (BI2000013102).
- Coating of solid propellant ingredients (BI2000013102).
- Secondary injection thrust vector control (BI2000020702).
- Engines using chlorine trifluoride and/or chlorine pentafluoride as oxidizers (BI2000010505).
- Ignitability and ignition testing of igniter materials and solid propellants (BI2000010506).
- Carbon-silicon carbide (C-SiC) use in missile applications (BI1999110501).
- Rocket engine recommended test practices (BI2000030202).
- High burning rate, high exponent solid propellant development (BI2000022301).
- Pressure measurements inside artillery guns (BI2000022302).

Recent CPIA Publications

CPTR-99-69, *Burning Rates of Standard Solid Propellants for Gun Applications,* September 1999.

CPIA Home Page

http://www.jhu.edu/~cpia/

Go There!

The Chemical Propulsion Information Agency (CPIA), a DoD Information Analysis Center, is sponsored and administratively managed by the Defense Technical Information Center (DTIC). CPIA is responsible for the acquisition, compilation, analysis, and dissemination of information and data relevant to chemical, electric, and nuclear propulsion technology. In addition, CPIA provides technical and administrative support to the Joint Army-Navy-NASA-Air Force (JANNAF) Interagency Propulsion Committee. The purpose of JANNAF is to solve propulsion problems, affect coordination of technical programs, and promote an exchange of technical information in the areas of missile, space, and gun propulsion technology. A fee commensurate with CPIA products and services is charged to subscribers, who must meet security and need-to-know requirements.

The *Bulletin* (circulation: 4,645) is published bimonthly and is available free of charge to the propulsion community. Reproduction of *Bulletin* articles is permissible, with attribution. Neither the U.S. Government, CPIA, nor any person acting on their behalf, assumes any liability resulting from the use or publication of the information contained in this document, or warrants that such use or publication of the information contained in this document will be free from privately owned rights. The content of the *Bulletin* is approved for public release, and distribution is unlimited.

Paid commercial advertisements published in the *Bulletin* do not represent any endorsement by CPIA.

Melissa A. Mason — Editor
Sharon P. Counihan — Layout Artist
(410) 992-7307 ext. 217 Fax (410) 730-4969
E-mail: mam@jhu.edu
World Wide Web: http://www.jhu.edu/~cpia/

The Johns Hopkins University/CPIA
10630 Little Patuxent Parkway, Suite 202
Columbia, Maryland 21044-3204

Operating under Contract: SPO700-97-D-4004

Mark your calendars now for the **29th United States Department of Defense Explosives Safety Seminar** to be held on 18-20 July 2000 at the Sheraton Hotel in New Orleans, Louisiana. This seminar is the premier event in the world for prominent military, industry, and international experts from the explosives safety community. The preliminary program and invitation will be distributed in April 2000.

Further information about this meeting can be obtained at the following websites: http://www.hqda.army.mil/ddesb/esb.html or http://www.jhu.edu/~cpia/ or by e-mail to DDESB seminar@jhu.edu.

See CPIA's Homepage "Calendar of Events" link (URL=http://www.jhu.edu/~cpia/)

Mark your calendars now for the **16 May 2000 Information Analysis Center Business Meeting** to be held at Wright Patterson AFB, Ohio.

This meeting is sponsored by the Defense Technical Information Center and will feature high level invited speakers from Wright Patterson Air Force Base as well as other key agencies.

For further details, please contact Donna Egner at 937-255-4840, or e-mail degner@bah.com

The *Bulletin* Board

The following are various meetings and events. We welcome all such announcements, so that the propulsion community can be better served with timely information. See back page for the JANNAF Calendar.

2000	Topic	Sponsor	Location
5/9-11	Cartridge Actuated Device and Propellant Actuated Device (CAD/PAD) Technical Exchange Workshop	NSWC	Waldorf, MD
5/10-12	AIAA Global Air and Space Conference and Exhibition	AIAA	Arlington, VA
6/19-22	Fifth International Symposium on Special Topics in Chemical Propulsion (5-ISICP): Combustion of Energetic Materials	Penn State Univ	Stresa, Italy
7/2-7	Gordon Research Conference on Energetic Materials	GRC	Tilton School, NH
7/16-19	36th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit	AIAA	Huntsville, AL
7/16-21	27th International Pyrotechnics Seminar	LANL	Grand Junction, CO
7/17-20	9th Annual AIAA/BMDO Technology Conference Exhibit	AIAA	San Diego, CA
7/18-20	DDESB 29th Explosives Safety Seminar	DDESB	New Orleans, LA
8/15-18	2nd International Hypersonic Wavrider Symposium	AIAA	Monterey, CA
9/18-20	Aerospace Materials, Processes, and Environmental Technology Conference	MSFC	Huntsville, AL
10/20-11/1	Space Business Conference and Exhibition	AIAA	San Jose, CA
11/7-10	AIAA 2000 Missile Sciences Conference	AIAA	Monterey, CA
2001	**Topic**	**Sponsor**	**Location**
1/8-11	39th AIAA Aerospace Sciences Meeting and Exhibition	AIAA	Reno, NV
4/TBD	42nd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference - AIAA/ASME/AHS Adaptive Structures Forum - AIAA Forum on Non-Deterministic Approaches	AIAA	TBD
7/6-14	37th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit	AIAA	Salt Lake City, UT
11/6-8	18th Symposium on Explosives and Pyrotechnics	FAPI	Philadelphia, PA

AIAA = American Institute of Aeronautics and Astronautics (703) 264-7500, (800) 639-2422, or http: //www.aiaa.org
DDESB = U.S. Department of Defense Explosives Safety Board, Dorothy L. Becker (410) 992-7302, or dlbecker@jhu.edu
FAPI = Franklin Applied Physics, Inc., James G. Stuart, Ph.D. (610) 666-6645
GRC = Gordon Research Conference, Richard Behrens (Sandia National Labs), (925) 294-2170, or fax: (925) 294-2276
LANL = Los Alamos National Lab, Alita Roach (505) 665-6277, or fax: (505) 665-3407
MSFC = Marshall Space Flight Center, Jodi Weiner (256) 533-5923, or jweiner@aol.com
NSWC = Naval Surface Warfare Center (Indian Head), Dave Brooks (301) 744-6705, or brooksdh @ih.nvy.mil; Chris Nugent (301) 744-2355, or nugentcm@ih.navy.mil; Nancy Willett (301) 744-2300, or willettnl@ih.navy.mil
Penn State Univ = Professor Kenneth K. Kuo (814) 863-6270, or fax: (814) 863-3203

JANNAF Meeting Reminders

29th PDCS & 18th S&EPS Joint Meeting
May 8-12, Cocoa Beach, FL

24th EPTS & 7th SPIRITS User Group Joint Meeting
May 15-18, Nellis AFB, FL

The JHU Applied Physics Laboratory Continues...*continued from page 1*

of RBCC-specific operations and flowpath characteristics, using its high-speed wind tunnel test cells and long experience in similar dual-combustor ramjet/scramjet research. Laboratory-developed analytical tools have been applied to a subscale, axisymmetric RBCC configuration, to evaluate the engine's theoretical performance and to guide the test program. Tharen Rice of the RTDC is currently conducting tests to assess the effect of air augmentation on the operation at low Mach numbers in a heavyweight, heat-sink engine.

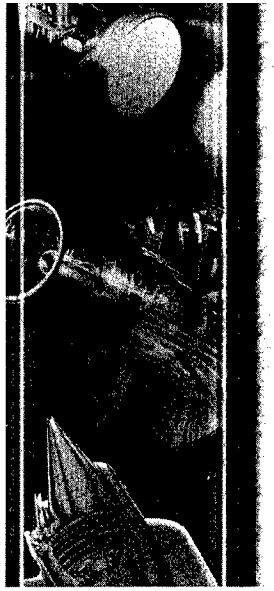
As part of the JHU/APL RTDC, the W. H. Avery Advanced Technology Development Laboratory (AATDL) maintains a hypersonic wind tunnel complex for investigation of aerospace technologies related to interceptor missiles, cruise missiles, space-access vehicles, and long-range high-speed aircraft. The AATDL was constructed in the early 1960's for investigations into the performance and operability of ramjet and scramjet engines. The AATDL facilities provide capabilities for aerothermal testing from Mach 4 to Mach 7, whereby various structures and materials can be exposed to high-speed flow environments at varying angles-of-attack and altitude conditions. The aerothermal freejet wind tunnel in Test Cell 5 is capable of simulating the aerothermal environment up to Mach 8 and has been an integral part of the IR Dome development for STANDARD Missile for over a decade. The AATDL also provides direct-connect and free-jet testing of air-breathing engine components, and maintains the capability to design and fabricate wind-tunnel models.

The principal components of the AATDL facility, shown in Figure 1, include a high-pressure airfield, air distribution network, five test cells, and a two-stage steam ejection exhaust system for altitude simulation. Major subsystems include the delivery systems for oxygen, hydrogen, hydrocarbon fuel, and cooling water and the facility control and data acquisition systems. Flow rates for all gases are computer controlled using digital values enabling accurate single-point flow simulation as well as a variable-condition trajectory simulation. Test time for combustion tests can be set by different subsystems depending on the test requirement. To prepare for hypersonic engine testing being planned by DARPA and ONR, JHU/APL made a major capital investment in 1998 to refurbish the large-scale, direct-connect scramjet combustor test all previously operational under the National Aerospace Plane Program. This test cell is capable of testing full-scale, tactical missile size combustors up to approximately Mach 8. The refurbished direct-connect combustor test cell (Test Cell 1) is shown in Figure 2 (on page 5) where a two-dimensional scramjet combustor is installed. In its current configuration, the airstream is brought online through a flexible bellows system to allow direct measurement of combustor thrust. A large scale calorimeter is used to determine combustion efficiency. The vitiated air system, supply nozzle, thrust stand, and combustor are shown in Figure 2. This test cell was recently used for DARPA Laser Ignition Studies and is currently being modified to test a full scale DCR combustor rig under the ONR HWT Program. Test Cell 2 is the freejet compliment to Test Cell 1 with capability to test freejet rigs up to Mach 7 in a 15.2-inch diameter axisymmetric nozzle.

In addition to combustion testing, the AATDL maintains test capabilities for materials evaluation, electric power control, sensor window development, and assess-

continued on page 5

36th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit



16–19 July 2000

Von Braun Civic Center • Huntsville, Alabama

Propulsion–Key to Exploring New Worlds

Early Registration Deadline: 16 June 2000

Technical Sessions

- Electric Propulsion
- Solid Rockets
- Future Flight Systems
- Launch Vehicles
- Hybrid Rockets
- Analysis and Componet Technology
- Energetic Componets and Systems
- Propellants and Combustion

This is just a few of the technical sessions being featured at the Joint Propulsion Conference. The completely searchable program is available at http://www2.aiaa.org/programs/joint00-search.cfm.

AIAA Professional Development Short Courses

20–21 July 2000

Solid Rocket Propulsion Status & Evolution

Organized by
AIAA Solid Rockets Technical Committee

Electric Propulsion For Space Systems

Instructors: Dr. Frank M. Curran, Dr. David King, Dr. Paul J. Wilbur, and Dr. L. Kevin Rudolph

Liquid Rocket Propulsion–Evolution and Advancements II

Instructors: Deborah Paul, Randy Parsley, Dr. Ray Moszee, Steve Bouley, Brian Winters, and Dr. Rob McAmis

Future Flight Propulsion: Advanced Concepts in Rocket Propulsion, Nuclear Systems, Advanced Physics, and High-Energy Density Propellants

Instructors: Bryan Palaszewski, Dr. Stanley Borowski, Dr. Robert H. Frisbee, Dr. Franklin B. Mead Jr., and Charles Garner

Register for one of these professional development courses and receive FREE admittance to the Joint Propulsion Conference and Exhibit. This special offer does not include the receptions, luncheons, papers, or any other ancillary or special conference functions. These items can be purchased separately.

Complete information for each of these courses can be obtained from AIAA's Web site at www.aiaa.org or by calling AIAA at 703/264-7500.

Meeting Information

Exhibits

The exhibits will feature organizations involved in liquid, solid, nuclear, electric, and other forms of propulsion for aerospace, as well as those involved in engine systems, environmental controls systems, ground support equipment, software, testing, analysis research and development, management, propellant tanks, thermal products, noise and vibration, and simulation components of this technology.

Exhibit Hours

Monday, 17 July . . . . . .1000–1600 hrs
Reception . . . . . .1800–1930 hrs
Tuesday, 18 July . . . . . .1000–1600 hrs

Register in advance and save $50!

Conference participants are encouraged to use the registration form on the back of this page. Save $50 off the regular rate when AIAA receives your registration with payment by 16 June 2000.

Accommodations

AIAA has made arrangements for blocks of rooms at Huntsville area hotels. The housing form may be downloaded from the Web at www.huntsville.org/jpc2000. All reservations must be returned to the Huntsville CVB Housing Department by fax at 256/551-2324 or by mail at 700 Monroe Street, Huntsville, AL 35801. These rooms will be held for AIAA until 15 June 2000 and then released for use by the general public. A deposit equal to $100 will be required to secure your reservations. Government Employees–There are a limited number of sleeping rooms available at the government hotel per diem at each property. Identification is required.

Corporate Sponsors

- Aerojet
- Atlantic Research
- Boeing Rocketdyne
- CSC
- Lockheed Martin
- Sverdrup
- SNECMA
- Thiokol
- TRW
- Pratt & Whitney UTC

36th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit

16–19 July 2000

Von Braun Civic Center • Huntsville, Alabama

REGISTRATION FORM

1 **All registrants please complete the information below.** 0414CPIA

Conference Badge Name First/Given Name M.I. Last/Family Name

Organization Name/Division/Mailstop

Address Line 2

City State Country/ZIP/Postal Code

E-mail Address Daytime Phone Number

Fax Number (include country code) Job Title/Rank

3 **AIAA MEMBERSHIP:** For those paying the full nonmember conference registration fee, sign below to receive your complimentary one-year AIAA membership. (Offer valid within six months of conference start date.) By completing this form, you acknowledge that AIAA needs the information requested here to provide you with the best possible service. From time to time, we make member and customer information available to companies whose products and services may be of interest to you. If you do not want your name and address exchanged, please check here: ❑

Signature _____ Date _____

Check here ❑ if you are renewing or reinstating your membership.
(You must pay full nonmember conference fee.)

4 **RETURN FORM TO:**
American Institute of Aeronautics and Astronautics
Dept. #4260
P.O. Box 85080
Richmond, VA 23285-4260
Fax: 703/264-7657

Registration forms must be received by **16 June 2000** to receive lower early bird rate. Registration forms **cannot** be processed without full payment.

Cancellations must be received in writing no later than **21 June 2000**. There is a $50 cancellation fee. Registrants who cancel beyond this date or fail to attend will forfeit the entire fee. For questions, call 800/639-AIAA or 703/264-7500 (outside U.S.).

5 Check here if you need to make special arrangements due to a disability. Attach requirements on a separate sheet of paper. ❑

6 **FORM OF PAYMENT**

AIAA Member No._____

❑ Purchase Order ❑ American Express
❑ Check ❑ VISA
❑ Travelers Check ❑ MasterCard
❑ Wire Transfer ❑ Diners Club

Credit Card Number:

Expiration Date: _____Month _____Year

Signature _____

Please check the society to which you belong.

❑ AIAA ❑ ASME
❑ SAE ❑ ASEE

FOR AIAA USE ONLY

Rec'd by _____

Date processed _____

Amount rec'd _____

2 Select your registration options below. Payment by check, credit card, or money order—payable to AIAA—must accompany registration. To pay the member rate, your membership must be in good standing.

REGISTRATION OPTIONS

	Early Bird By 16 Jun 00		Late/On Site After 16 Jun 00	
	Society Member	Non-Member	Society Member	Non-Member
OPTION 1: PROFESSIONAL DEVELOPMENT				
Future Flight Propulsion: Advanced Concepts in Rocket Propulsion, Nuclear Systems, Advanced Physics, and High-Energy Density Propellants	❑$700 (A1)	❑$800 (B1)	❑$745 (C1)	❑$845 (D1)
Solid Rocket Propulsion Status and Evolution	❑$705 (E1)	❑$800 (F1)	❑$745 (G1)	❑$845 (H1)
Electric Propulsion for Space Systems	❑$700 (I1)	❑$800 (J1)	❑$745 (K1)	❑$845 (L1)
Liquid Rocket Propulsion—Evolution and Advancements II	❑$755 (M1)	❑$850 (N1)	❑$795 (O1)	❑$895 (P1)

Register for one of the above courses and attend the Joint Propulsion Conference and Exhibit for free. (Includes sessions, exhibits, and Monday exhibits reception only.)

OPTION 2: FULL CONFERENCE W/ LOOSE PAPERS
❑$400 (A2) ❑$525 (B2) ❑$450 (C2) ❑$575 (D2)
(Includes sessions, exhibit, Sunday evening reception, Monday boxed lunch, Monday exhibits reception, Tuesday awards luncheon, and one copy each of up to 10 papers.)

OPTION 3: FULL CONFERENCE W/CD-ROM (PC ONLY)
❑$565 (A3) ❑$690 (B3) ❑$615 (C3) ❑$740 (D3)
(Includes sessions, exhibit, Sunday evening reception, Monday boxed lunch, Monday exhibits reception, Tuesday awards luncheon, and conference CD-ROM.)

OPTION 4: FULL-TIME STUDENT
❑$0 (A4) ❑$25 (B4) ❑$10 (C4) ❑$35 (D4)
(Includes sessions, exhibits Sunday evening reception, and Monday exhibits reception only.)

OPTION 5: FULL-TIME RETIRED MEMBER
❑$0 (A5) N/A ❑$10 (B5) N/A
(Includes sessions, exhibits Sunday evening reception, and Monday exhibits reception only.)

OPTION 6: BLOCK (ADVANCE ONLY)
❑$305 (A6) ❑$305 (B6) N/A N/A
(One complete typed list plus individual registration forms for 10 or more persons from same organization. Includes sessions, exhibits Sunday evening reception, and Monday exhibits reception only.)

OPTION 7: TUESDAY EVENING OFFSITE EVENT HUNTSVILLE SPACE & ROCKET CENTER DINNER
❑$5 (A7) No. of tickets ____ Tickets are limited, so sign up now!

ACCOMPANYING PERSON:
Attending Monday's breakfast? ❑ Yes ❑ No
Name: _____

EXTRA TICKETS

Monday Boxed Lunch	❑$13 (T1)	No. of tickets____
Monday Exhibts Reception	❑$22 (T2)	No. of tickets____
Tuesday Awards Luncheon	❑$25 (T3)	No. of tickets____
Extra CD-ROM (PC only)	❑$200 (T4)	No. of copies____

TOTAL DUE: $ _____

Early bird registration deadline: 16 JUNE 2000

rev 4/99

The JHU Applied Physics Laboratory Continues...*continued from page 4*

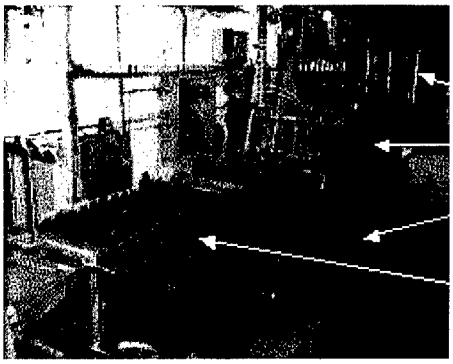


Figure 2. Direct-Connect Scramjet Test Cell

ment of advanced aerodynamic control techniques. As an example, the AATDL has developed facilities for investigating the control of supersonic flow using plasma aerodynamics techniques. An example is shown in Figure 3, which is a photograph taken from an experimental set-up that allows investigation of the effects of electrical discharges in supersonic flows. In this facility, the use of electric discharges for significantly modifying flows has been demonstrated.

After many years of using the AATDL test facilities solely for U.S. Government Programs, JHU/APL has established alliances that enable industry to contract directly with the Laboratory for test services. The propulsion test facilities are made available under the Alliance for High-Speed Propulsion Testing and the aerothermal test capabilities are made available under the Alliance for High-Speed Aerothermal Sensor Testing.

While JHU/APL has maintained a strong research role in air-breathing engine work for missile propulsion for many years, it has also engaged in the development of broader guided missile technologies since the mid 1940's. Consequently, the application of various non-air-breathing propulsion technologies has been a central part of many past and ongoing Laboratory projects, including the assessment of conventional and alternative propulsion technologies. In its role as a systems engineer, JHU/APL assesses the impact of competing propulsion technologies on system performance, operability, and functionality. The Lab may conduct experimental investigations of propulsion elements or applications, to provide a basis for these assessments.

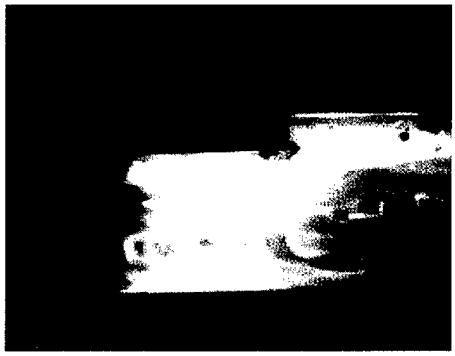


Figure 3. Mach 2.7 Flow Around Sphere with Upstream Electrical Discharge.

As an example, hybrid rocket propulsion is a technology of potential interest for a number of applications where thrust magnitude control is desirable, along with the simplicity and relatively high performance of a solid rocket motor. To evaluate the potential of this technology, Harry Hoffman and Dan Simon are engaged in fundamental studies of conventional hybrid rockets to evaluate hybrid-unique phenomena. Facilities include a thrust

continued on page 6

The JHU Applied Physics Laboratory Continues...*continued from page 5*

stand with a mass-flow-controlled reactant (fuel or oxidizer) injector, and instrumentation to closely monitor the flow conditions at various points in the operation to permit complete control and evaluation of the unit operation. Goals of the project include careful evaluation of basic phenomena and underlying mechanisms involved in transients (ignition rise, thrust tail-off, throttling), and predictability of recession.

Finally, as an adjunct to its technology work relating to vehicle performance and systems engineering, JHU/APL has developed approaches to detection and assessment of energetic material aging. Dr. Lawrence Hunter has developed an experimental method for detecting chemical aging of energetic (propellant) materials, along with the necessary chemical aging models that form the theoretical basis for the technique. The method has been experimentally evaluated; remaining life is predicted using chemical aging models developed for the particular material formulation. The method appears to be applicable to a wide range of chemical aging situations.

Other recent JHU/APL propulsion-related projects and initiatives include the investigation of lasers to ignite or pilot mixed gaseous fuels and oxidizers (part of a DARPA-funded effort in 1998), microsatellite propulsion, high temperature materials, light-gas-gun launch systems, and advanced "smart" composite structural materials.

The JHU/APL is poised to continue its role as a developer, and evaluator, and a user of propulsion technology in the new century with its ongoing research and technology development, and systems engineering efforts. JHU/APL will continue to evaluate and apply technology advancements to further the capabilities of systems of national importance.

For further information please contact Mr. Harry Hoffman at (443) 778-8870, or e-mail: harry.hoffman@jhuapl.edu.

LOCKHEED MARTIN
Naval Electronics & Surveillance Systems

Low Cost Ablative, Insulating, Structural and Adhesive Materials for Aerospace Applications

Lockheed Martin Naval Electronics & Surveillance Systems *(LM NE&SS-Baltimore)* is seeking sources for low cost, high performance materials for use in high temperature gas management subsystems. Technical performance requirements for the various technologies of interest are described in the following paragraphs.

1) High Temperature Structural Ablative System: Materials are required to withstand heat fluxes up to 900 BTU / ft^2-sec for up to 10 seconds. Gas temperature is 3500F. The material or system should be compatible with box and tubular shaped form factors. Average density not to exceed 200 lbs / ft^3. Thin tube thickness is needed, so high strength materials are required.

2) Low Cost, High Temperature Ablative Materials: Materials are required to withstand heat fluxes up to1600 BTU / ft^2-sec for up to 10 seconds. Gas temperatures are as high as 6000F. Acceptable materials must be able to protect structural components from excessive heating and erosion. Density not to exceed 200 lbs / ft^3. Low thermal conductivity is desired, and shall be a maximum of 65 BTU/ hr/ ft^2/F/ft. The material should have a failure strain greater than 0.14%. High temperature and room temperature cure materials will be considered.

3) Low Cost, High Temperature Adhesive Materials: New adhesive materials are needed to bond metals to composites and require a minimum shear strength of 350 psi at 300F. Primary factors for adhesives will be low cost and high strength at elevated temperature. The adhesive should be a thick paste capable to form a .030"- .150" bond line. Room temperature cure adhesive is desirable.

4) Low Cost, High Temperature Insulating Materials for Low Heat Flux Environments: Materials will operate in low heat flux environments of 75 BTU/ ft^2-sec. Less than 1 BTU/ hr/ ft^2/F/ft thermal conductivity is required. Spray, brush or trowel application is desirable. No material strength is required, but the material should remain attached to the metal while subjected to high subsonic hot gasses.

5) Low Cost, High Temperature Insulating Materials for High Heat Flux Environments: Materials are required to withstand heat fluxes up to 1200 BTU / ft^2-sec for up to 1.7 minutes. Gas temperature is 3500F. Less than 1 BTU/ hr/ ft^2/F/ft thermal conductivity is required. Spray, brush or trowel application is desirable. Surfaces will be flat, steel plates. No material strength is required, but the material should remain attached to the metal while subjected to high subsonic hot gasses.

Interested contractors should respond by May 31, 2000. Responses to be sent to Lockheed Martin NE&SS-Baltimore, 2323 Eastern Boulevard, Baltimore MD 21220-4207, Attention: David Luksik, M/S 800W.

Responses should include the following information:

1. Description of recommended materials/technology.
2. Description of current application or development of the subject materials/technology.
3. Materials properties test data.
4. Description of manufacturing process required for material fabrication.
5. Materials cost (per pound, per square foot of thickness).
6. Contractors are strongly encouraged to submit responses addressing low cost approach in material selection and fabrication.
7. Contractor credentials demonstrating previous experience in designing and developing material in specified area, including key technical personnel and in-house production facilities.

This solicitation should not be construed as a commitment or authorization to incur costs in anticipation of a resultant contract. Information provided herein is subject to modification and in no way binds Lockheed Martin to award a contract.

CPIA Bulletin

U.S. POSTAGE
PAID
COLUMBIA, MARYLAND
PERMIT No. 425
NONPROFIT ORGANIZATION

Johns Hopkins University/Chemical Propulsion Information Agency
10630 Little Patuxent Parkway, Suite 202
Columbia, MD 21044-3204
Phone (410) 992-7300

ADDRESS CORRECTION REQUESTED

Official Business

Library
Defense Technical Information Center
8725 John J Kingman Rd
DTIC-OCP
Fort Belvoir VA 22060-6217

JANNAF MEETING CALENDAR

2000	Meeting	Type	Location	Abstract Deadline	Paper Deadline
May 8-12	29th Propellant Development Characterization Subcommittee and 18th Safety and Environmental Protection Subcommittee Joint Meeting	Conference/ Workshop	Cocoa Beach, FL	Past	Past
May 15-18	24th Exhaust Plume Technology Subcommittee and 7th SPIRITS User Group Joint Meeting	Conference	Nellis AFB, NV	Past	Past
Nov. 13-17	37th Combustion Subcommittee, 25th Airbreathing Propulsion Subcommittee, 19th Propulsion Systems Hazards Subcommittee, 1st Modeling and Simulation Subcommittee Joint Meeting	Conference/ Workshop	Monterey, CA	May 15	Oct. 23
2001	**Meeting**	**Type**	**Location**	**Abstract Deadline**	**Paper Deadline**
Mar. 26-30	12th Nondestructive Evaluation Subcommittee, 21st Rocket Nozzle Technology Subcommittee and 34th Structures and Mechanical Behavior Subcommittee Joint Meeting	Conference/ Workshop	Cocoa Beach, FL	TBA	TBA
July 11-13	50th JANNAF Propulsion Meeting	Conference	Salt Lake City, UT	TBA	TBA

Attendance at JANNAF Conferences and Workshops is by invitation only.
MEETING CALENDAR SUBJECT TO CHANGE. FOR LATEST DETAILS, CONTACT CPIA AT (410) 992-7304.
Printed on recycled paper